ACQUISITION COSTS VERSUS LIFE CYCLE COSTS

PRESENTATION BY:
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Partner
Arthur Andersen & Co.

APTA MID-YEAR MEETING
MECHANICAL DIVISION SESSION
MAY 22, 1975

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Today I'm going to talk about acquisition costs versus life cycle costs in bus purchases.

Consultants are supposed to be objective. So it's only fair that I tell you now, at the outset, that I've reached some definite conclusions on the subject of whether bus purchase decisions should focus on the acquisition cost (or purchase price) of competing buses, or whether the focus should be on their life cycle costs. By "life cycle costs" I mean purchase price plus O&M costs over the life of the vehicle.

I think that the decision maker should focus on life cycle costs, not on acquisition cost alone. Today, I'd like to explain the reasoning behind that conclusion, and also describe an approach toward analyzing life cycle costs.

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2. IMPORTANCE OF LIFE CYCLE COSTS
3. USE OF LIFE CYCLE COSTS APPROACH IN OTHER INDUSTRIES
4. APPROACH TO ANALYZING LIFE CYCLE COSTS
5. SIGNIFICANT DATA ELEMENTS
6. DATA MEASUREMENT
7. CURRENT DEVELOPMENTS REGARDING UMTA POLICY

This slide shows the outline I will follow for the talk. I will start by briefly reviewing present UMTA policy regarding bus purchases. Then I will establish the fact that life cycle costs are important in the acquisition decision and give examples of the use of the life cycle cost approach in other industries. After establishing their importance, I will discuss two approaches for analyzing life cycle costs. Both approaches require measurement of certain elements that are of significance to the purchase decision, so I will identify those significant elements and discuss how they can be measured or estimated. I will discuss current developments regarding UMTA's policy, and–finally–I'll close with several conclusions.

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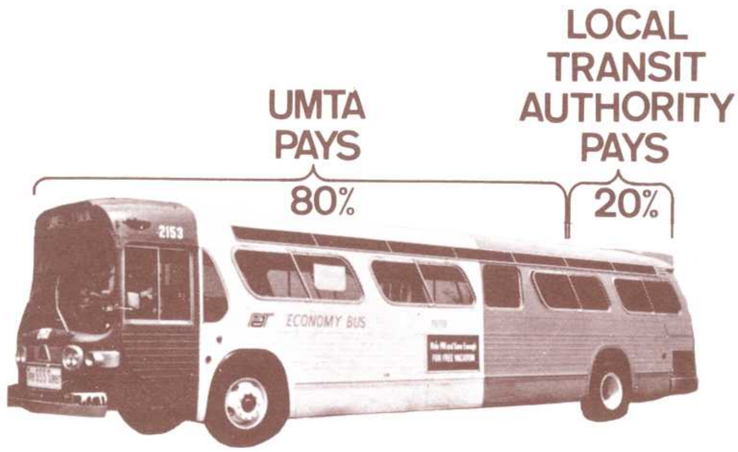
Turning now to present UMTA policy regarding bus purchase decisions, it is clear that the policy does not favor a life cycle cost approach.

PRESENT UMTA POLICY



LOWEST ACQUISITION COST BUS

Under the capital grant program, UMTA will reimburse the local transit authority 80% of the acquisition cost of the lowest responsive bid, and the local transit authority must pay the remaining 20%.

While it is not stated in writing, UMTA seems to have adopted a "show-me" attitude in the capital grant area. Since there is no industry standard for what should and should not be counted in determining life cycle costs, and there is some feeling that existing data is not sufficient to estimate life cycle costs accurately; *some attempts* to work life cycle costs into the specifications or award determination have been construed to be attempts to tilt the award.

While I certainly can't speak for UMTA, I do believe that the industry has an opportunity to demonstrate the advantages of using life cycle costing. Further, if we, for the sake of argument, can ignore the 80%-20% leveraging, we can also avoid the disposable bus syndrome whereby heavily subsidized capital costs are increased to minimize less subsidized operating costs.

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Now, the first step in determining if the life cycle cost approach is worthwhile is to verify that life cycle costs are, in fact, important to the purchase decision.

LIFE CYCLE COSTS ARE SIGNIFICANT RELATIVE TO ACQUISITION COST

	RANGE	
	Low	High
Annual Operating Cost/Mile	$ .44	$ 2.35
	X	X
Total No. of Miles Driven	500,000	500,000
	⇓	⇓
Total Life Cycle Cost	$220,000	$1,175,000
Typical Acquisition Cost	$45,000+	

A 1974 report released by UMTA states that annual operating costs for buses ranged from a low of $.44 per mile to a high of $2.35 per mile. Assuming a 500,000 mile life for a bus, that means that the life cycle costs could range from $220,000 to $1,175,000. Even the lower figure is several times greater than the acquisition cost of a bus. Indeed, life cycle costs are significant.

This slide may tend to exaggerate the differences in life cycle costs since the $.44 to $2.35 operating cost per mile include operator wages. Operator wages are not likely to vary when comparing the life cycle costs of one bus to another, so they can be removed from the calculation.

Deducting operator wages from consideration of life cycle costs, the sum of maintenance cost, fuel consumption cost, and tire cost result in an annual cost ranging from $.13 per mile to $.67 per mile. But the wide variation between these figures exists most likely because the specifications for the various buses differ widely.

A given local transit authority probably is not going to be considering buses with such a wide difference in life cycle costs since the buses would have to meet certain specifications and should perform similarly. Yet, although the buses do perform somewhat similarly, differences do exist.

DIFFERENCES EXIST IN FUEL CONSUMPTION COSTS

— SCRTD SAMPLE:	LOW:	$.091 per MILE
	HIGH:	$.120 per MILE

MANUFACTURER/TYPE/MODEL	Miles/Gallon	$/Mile
OVERALL	4.53	$.111
A	4.15	.120
B	4.37	.114
C	4.71	.106
D	4.90	.102
E	5.49	.091

This slide contains sample data from the Southern California Rapid Transit District (SCRTD). Miles per gallon figures can range from 4.15 mpg to 5.49 mpg resulting in a range of *fuel cost* per mile of nine point one cents to twelve cents. Models chosen for this slide were picked because the SCRTD had large numbers of vehicles of these particular models and type so that the figures would tend not to be biased by sample size or route assignments.

DIFFERENCES EXIST IN MAINTENANCE COSTS

— SCRTD SAMPLE:	LOW:	$.048 per mile
	HIGH:	.130 per mile

MANUFACTURER/TYPE	MAINTENANCE COST/MILE
OVERALL	$.111
A	.048
B	.070
C	.070
D	.095
E	.104
F	.116
G	.130

The same holds for this next slide of sample *maintenance costs* of SCRTD buses of different types. You can see that maintenance costs for these sample models vary over $.08 per mile, from less than a nickel to 13 cents. So, differences *do* exist in life cycle costs of similar buses.

EXAMPLE OF NEED TO CONSIDER LIFE CYCLE COSTS

BUS "A" COSTS $2000 LESS INITIALLY . . .

	Acquisition Cost	No. of Miles Per Year	O & M Cost Per Mile	Annual Cost to Run Buses
A:	$46,000	40,000	$.55	$22,000
B:	$48,000	40,000	.50	20,000

BUT BUS "B" COSTS $2000 LESS PER YEAR

Let's see how differences as small as 5 cents per mile stack up against acquisition costs.

Assume that bus "A" costs $46,000 and bus "B" costs $48,000. Thus, bus "A" has an initial cost advantage of $2,000. Please note that we have used these low acquisition costs as they are compatible with the operating cost data we obtained and that data is a couple of years old. Assume that both buses will be driven 40,000 miles during the first year.

Now assume bus "A" costs $.55 per mile to operate and maintain, and bus "B" $.50. Both figures exclude operator wages. This is a difference of only $.05 per mile, not an especially large difference when you remember that differences of over $.08 per mile in maintenance costs alone can be seen at SCRTD.

Applying this $.05 per mile saving for bus "B" to the 40,000 miles driven that year results in a $2,000 saving in O&M costs for bus "B." Thus, in one year, bus "B" has wiped out "A's" initial cost advantage, and in this simple example, "B's" $2,000 per year advantage would continue every year for the life of the buses. Bus "A" no longer looks like the better deal when life cycle costs are considered.

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The life cycle cost approach is being used on purchase decisions in many industries. Here are a few examples.

EXAMPLES OF INDUSTRIES USING LIFE CYCLE COSTS

PRIVATE

- Telephone
- Utilities
- Airlines

GOVERNMENT

- Department of Defense (DOD)
- General Services Administration (GSA)

The telephone and utilities industries use the life cycle cost approach extensively in purchase decisions for plant and equipment and also for less expensive items used frequently.

The airline industry includes a consideration of fuel consumption and maintenance expenses in its acquisition decisions for new planes.

The Department of Defense has awarded dozens of contracts on a life cycle cost basis. Typical applications are contracts for diesel engines and aircraft tires.

The Federal Supply Service (FSS) Division of GSA recently conducted a study regarding life cycle costs. The study concluded that life cycle costs were appropriate for FSS. Even with increased administrative cost for FSS resulting from increased time spent estimating costs, the agency concluded it benefitted because total costs would be lower.

In addition to the examples shown on the chart, it should be noted, too, that some transit authorities, most prominently the Ottawa-Carleton Regional Transit Commission, already consider life cycle costs in purchase decisions, as many of you know, Hector Chaput has presented a paper on their approach to life cycle costing.

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At this point, then, we have established that life cycle costs are important and that the life cycle cost approach is used in various industries. Now I will discuss two approaches for analyzing life cycle costs.

TOTAL DOLLAR OUTLAY APPROACH

Choose bus with the lowest total dollar outlay over its lifetime.

PROBLEM: Ignores time value of money

The first approach is to use total dollar outlays regardless of when they occur. Simply stated, the idea behind this approach is to choose the bus model requiring the lowest total dollar outlay, i.e., the lowest sum of acquisition plus life cycle costs, this approach does not result in an accurate picture of the economics which should bear on the decision because it ignores the time value of money.

$1.00 TODAY WORTH MORE THAN $1.00 ONE YEAR FROM NOW EVEN IGNORING THE EFFECTS OF INFLATION.

	Dollar Today	Dollar in One Year
Received Today	1.00	– –
Interest @ 8%	.08	– –
Received in One Year	– –	1.00
TOTAL	1.08	1.00

PRESENT VALUE OF $1.08 ONE YEAR FROM NOW = $1.00

PRESENT VALUE FACTOR $= \frac{\$1.00}{\$1.08} = .9259259$

$1.00 ONE YEAR FROM NOW WORTH $.9259259 TODAY

Even ignoring the effects of inflation, a dollar you have today is worth *more* than a dollar you will get one year from now. If you have that dollar today you can earn money with it. For example, if the dollar you have were invested at 8%, the dollar would be worth $1.08 one year from now.

Likewise, you could say that at an interest rate of 8% that $1.08 one year from now is worth $1.00 today. Another way of saying that is that $1.08 one year from now has a *present value* of $1.00, assuming an 8% interest rate. From this information we can calculate a present value factor equal to $1.00 divided by $1.08 which is .9259259. What this means is that $1.00 one year from now is worth a little over 92-½ cents today assuming an 8% interest rate.

Similar present value factors can be determined for any length of time and any interest rate. Indeed, entire present value tables have been developed. They are commonly found in recent accounting and finance texts or in special books of present value tables.

PRESENT VALUE APPROACH

Choose the model with the lowest aggregate present value of acquisition cost plus life cycle costs.

I have just described to you the basic premise for the present value approach to analyzing life cycle costs. Under this approach, the transit authority should choose the model with the lowest aggregate, i.e., present value of acquisition costs plus life cycle costs. By using aggregate figures the possibility is accounted for that although one bus may individually have a lower present value cost, a larger number of that type of bus may be required because of reliability factors, making the overall contract cost greater. (More about that later)

PROCEDURE FOR PRESENT VALUE APPROACH

1. ESTIMATE ANNUAL DOLLAR OUTLAYS FOR A SINGLE BUS
2. RESTATE ALL DOLLAR AMOUNTS IN PRESENT VALUE TERMS
3. SUM ALL PRESENT VALUE AMOUNTS
4. MULTIPLY THE SUM BY THE NUMBER OF BUSES REQUIRED
5. CHOOSE THE BUS MODEL WITH THE LOWEST AGGREGATE PRESENT VALUE COSTS

This slide identifies the 5 steps to follow in applying the present value approach. The first step is to estimate annual dollar outlays for each year of the life of the bus. Then, after identifying an appropriate interest rate, use present value factors from present value tables to restate all dollar amounts in present dollar terms. Third, add up all of these present dollar amounts to obtain the present value cost of a single bus. Then, multiply that present value cost by the number of buses to be purchased. Finally, as step 5, the bus with the lowest aggregate present value cost can be chosen.

In the next 4 slides we'll work through an example to illustrate these steps.

ASSUMPTIONS USED IN PRESENT VALUE APPROACH EXAMPLE

– ACQUISITION COST

BUS	A	45,000
BUS	B	48,000

– 15 YEAR LIFE

– MILES TRAVELED

	Years		
	1–5	6–10	11–15
A	50,000	30,000	15,000
B	48,000	28,000	14,000

– 2,000,000 ROUTE MILES TO BE COVERED

A $\frac{2{,}000{,}000}{50{,}000} = 40$ BUSES

B $\frac{2{,}000{,}000}{48{,}000} = 41.6 \Rightarrow 42$ BUSES

The assumptions I used are as follows:

- A local transit authority must choose between bus model "A" and bus model "B." "A" costs $45,000 to acquire and "B" costs $48,000.
- Both "A" and "B" have a 15 year life.
- "A" will travel 50,000 miles per year in the first 5 years, 30,000 miles per year for years 6-10, and 15,000 miles per year for years 11 -15. "B," because of slightly less availability due to higher maintenance frequency, will travel only 48,000, 28,000 and 14,000 in the same periods.
- 2,000,000 route miles/year must be covered by the new buses resulting in requirements for 40 "A" buses or 42 "B" buses.

ASSUMPTIONS USED IN PRESENT VALUE APPROACH EXAMPLE

— Operating & Maintenance Costs Per Mile

	A	B
Maintenance Labor	$.20	$.22
Maintenance Parts	.20	.19
Fuel	.10	.07
Tires	.02	.02
TOTAL	$.52	$.50

— Engine Overhauls

	Year	Mileage	Cost
Major			
A:	5	250,000	$1200
B:	8	340,000	1200
Minor			
A:	10	400,000	800
B:	none		

— Interest Rate = 8%

- Continuing with the example, total operating and maintenance cost per mile for "A" equals $.52 and for "B" $.50. "B" requires more maintenance labor than "A" but uses cheaper parts. Another reason that "B" costs less to maintain is that "B" is expected to average 7 miles per gallon versus 5 miles per gallon for "A" resulting in a $.03 per mile fuel cost saving for "B." Please note that operator wages and general and administrative expenses are not included. They are not included because they would be the same for the two alternatives. In using the life cycle cost technique all costs that do not differ among the alternatives can be ignored. For simplicity in this example, I assumed that O&M cost per mile stayed consistent for the 15 years. In the real world, of course, you would probably find that maintenance costs are higher in certain later years.
- "A" requires a major overhaul costing $1,200 after 5 years and 250,000 miles, and a minor overhaul costing $800 after 10 years and 400,000 miles. "B" does not require the major overhaul until 8 years and 340,000 miles. No minor overhaul is required for "B."
- An interest rate of 8% was chosen since it is representative of the cost to the local transit authority of raising money.

EXAMPLE OF PRESENT VALUE APPROACH

Year	8% Present Value Factor	ANNUAL COSTS A Actual	A Present Value	B Actual	B Present Value
Acquisition	1.000000	45000	45000	48000	48000
1	.925926	26000	24074	24000	22222
2	.857339	26000	22291	24000	20576
3	.793832	26000	20640	24000	19052
4	.735030	26000	19111	24000	16334
5	.680583	27200	18512	24000	16334
6	.630170	15600	9831	14000	8822
7	.583490	15600	9102	14000	8169
8	.540269	15600	8428	15200	8212
9	.500249	15600	7804	14000	7003
10	.463193	16400	7959	14000	6485
11	.428883	7800	3345	7000	3002
12	.397114	7800	3097	7000	2780
13	.367698	7800	2868	7000	2574
14	.340461	7800	2656	7000	2383
15	.315242	7800	2459	7000	2207
Total Present Value			207,177		195,462

This slide presents the analysis of the problem just stated. Although it may look somewhat forboding, stay with me and it should make sense. I will explain the origin of the numbers in the columns.

The present value *factors* in col. 2 were taken directly from a present value table with an interest rate of 8%. The first entry in each of the two "actual" columns is the cost of acquiring "A" or "B." The "actual" amounts for years 1-15 represent the operating cost based on expected number of miles to be driven times the operating plus maintenance cost per mile. For instance, in year 1, "A" will travel 50,000 miles. At a cost of $.52 per mile, the actual cost for year 1 is $26,000. If you drop down to years 5 and 10 for "A" and year 8 for "B" you'll note that the cost of overhauls has been figured in. The "present value" column is simply the present value factor for that year multiplied by the actual amount to be spent in that year. Adding up the "present value" column, you obtain the present value cost of a single bus. You can see that "B" is roughly $11,000 cheaper than "A" on an individual present value basis.

EXAMPLE OF PRESENT VALUE APPROACH

	Present Value Cost of Individual Bus	Number of Buses Required	Aggregate Present Valve Cost
A	$207,177	40	$8,287,080
B	195,462	42	8,209,404

B IS A BETTER BUY THAN A

EVEN THOUGH ACQUISITION COST IS MORE

A	$45,000	40	1,800,000
B	$48,000	42	2,016,000

After multiplying 42 times the present value cost of a single "B" bus and 40 times the present value of a single "A" bus, the result is a bit surprising in that the "B" bus is still cheaper by more than $77,000.

So, even though "B" bus cost more initially and more of them were required, *because* of lower life cycle costs, "B" was still cheaper than "A." And the result is even more interesting because the difference in operating and maintenance costs between "A" and "B" was only $.02 per mile.

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As evident from the example, a major concern with the life cycle cost concept is in the need to estimate the life cycle costs themselves.

But before the costs can be estimated, those that are likely to be of significance must be identified. Those costs that will not vary among the alternatives can be eliminated from consideration. So, most likely, as in the last example, operator wages and general and administrative costs can be eliminated.

CONSIDER ONLY THOSE DATA ELEMENTS LIKELY TO VARY AMONG BUS MODELS

Elements Likely to be Significant

— Preventive Maintenance Costs
  - Labor
  - Materiels

— Repair Costs
  - Labor
  - Materiels

— Fuel Consumption Costs

— Tire Costs

The data elements that are likely to be important are preventive maintenance costs (both labor and material costs) such as:

- Tune-ups
- Brakes
- Shock Absorbers
- Transmission

Possibly, to that list could be added:

- Oil Changes
- Lubrication
- Safety Inspections

Other data elements likely to be important are repair labor and material costs. For example, repair costs for:

- Road Calls
- Engine Overhauls
- Air Conditioning
- Transmission
- Upholstery
- Windshield Wipers
- Body
- Doors
- Electrical System

In addition, fuel consumption cost and tire cost are likely to be important since they could vary among bus models.

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Of course, identifying data elements is not enough. The significant data elements must be measured since the need for quality data is important. The estimates of life cycle costs must be in the right ball park for the approach to have any validity

SOURCES OF DATA

1 Historical Records

— use when new bus similar to old

— requires Keeping accurate records

— FARE industry-wide data-base

2. Manufacturer's Specifications

— may be biased

— include penalty provision in contract for performance deficiencies

3. Testing

— by local transit authority

— by UMTA

— by manufacturer

There are three main sources of data for life cycle cost estimation: Historical Records, Manufacturer’s Specifications and testing.

Historical records are most valuable when the new bus is similar in design to previous models. This is the case most often since most design changes are evolutionary rather than revolutionary. Possibly, a transit authority could consult the historical records of another transit authority if that authority owned a bus model similar to the model under consideration for purchase. Or, if the project fare reporting system were expanded to include this level of detail, an industry-wide data base could become available. In any case, using historical records from anywhere requires that those records be accurate.

Manufacturer’s performance specifications are often a good source of data, but they must obviously be reviewed with caution.

A third source of data is testing. Testing could be performed by the local transit authority itself, by UMTA if the design is somewhat standardized, or by the manufacturer. An industry representative should observe the manufacturer’s test.

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Now, to return almost to where I started, UMTA's present policy does *not* include a consideration of life cycle costs in acquisition decisions.

However, UMTA is looking at the issue and a research study has been commissioned:

1. To examine current developments in the life cycle cost concept.
2. To identify UMTA programs where the life cycle cost concept is appropriate.
3. To estimate the effect of such applications, and
4. To suggest areas for further study.

This eighty-five thousand dollar study is being performed by the Naval Underwater Systems Center in Newport, Rhode Island under UMTA's direction. In the background information reflecting UMTA's interest in life cycle cost, UMTA provides an example application. *That* example used basically the same present value approach I just described.

Working with the transportation systems center, UMTA is also presently studying various levels of federal involvement in transit industry acquisitions. Judging from the preliminary reports from this study, it is likely that UMTA's role will increase and, as it does, UMTA's recognition of life cycle costs will increase also. The study noted that as federal involvement increases, so, usually, does use of the life cycle cost concept.

CONCLUSIONS

1. Life cycle costs are important in bus purchase decisions

2. Life cycle costs are used by several other industries in decision making

Now, on the last 3 slides, I'd like to summarize the main points I have made:

1. Life cycle costs are important in bus purchase decisions.
2. The Life cycle costs are used by several other industries in their decision-making.

CONCLUSIONS

3. Present value approach is the preferred method of analyzing life cycle costs.

4. The transit authority need consider only those costs that will vary among alternatives when applying the life cycle cost concept.

3. The present value approach is the preferred method for analyzing life cycle costs.

4. The transit authority need consider only costs that will vary among alternatives in life cycle costs analysis.

CONCLUSIONS

5. The transit industry should improve systems to improve historical records.
6. UMTA does recognize, and is studying, the potential importance of life cycle costs.

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Obviously, costs are an important factor but not the only factor in the purchase decision. Other considerations will undoubtedly include parts inventory and personnel training which arise from the composition of an existing fleet, operator acceptance and even aesthetic appeal. Nevertheless, it is clear that the use life cycle costs should contribute to a better purchase decision.

Dr, Ronan told us Tuesday that one of APTA's objectives is to improve the reliability and maintainability of transit vehicles. If purchase decisions are based on acquisition costs alone, there can be a strong incentive for manufacturere to reduce cost at the expense of reliability and maintainability. The use of life cycle costs, rather than acquisition costs alone, will provide manufacturers with a positive incentive to improve the reliability and maintainability of their vehicles.